A PLANT EXPLORATION IN BRASSICA AND ALLIED GENERA

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By

Usaburo MIZUSHIMA and Shigesaburo TSUNODA

Department of Agronomy, Faculty of Agriculture
Tohoku University, Sendai, Japan.

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Introduction

Studies on genetics and evolution of species in *Cruciferae*, especially of those belonging to the tribe *Brassiceae*, have been going on in the Laboratory of Genetics and Plant Breeding, Faculty of Agriculture, Tohoku University, Sendai. The tribe consists of seven subtribes with fifty-two genera (Schulz, 1), the species of which comprise many an agirculturally important variety as vegetable, oil, fodder, spice and medicinal crops such as the common cabbage, the cauliflower, the Chinese cabbage, the turnip, the swede, the radish, the mustard, and etc. As to the materials for the studies, numbers of strains of the species in the genera in *Brassiceae*, *viz.*, *Brassica*, *Sinapis*, *Diplotaxis*, *Eruca*, *Crambe*, *Raphanus*, and so on , have been grown annually during the past twenty years in the experimental field of the laboratory by the aid of special expenditure from the Ministry of Education. Their seeds have been distributed to researchers, both home and foreign, in the same field of study at their requests. They consisted, however, mostly of cultivated strains with comparatively few wild ones. The authors were, therefore, anxious to collect the latter which were indispensable for getting important information for elucidating the origin and differentiation of the former. Further, on the standpoint of practical breeding introduction of wild strains was also indispensable. However, in 1965 they were fortunate enough to have a chance to carry out a plant exploration in the centres of distribution of cruciferous plants through the aid of the Ministry of Education. By this trip they were able to collect seeds of seventeen genera in *Brassiceae* and twenty in other tribes which consisted of 110 species and 391 strains, most of these having never been introduced into Japan. Their names and origin are shown in Appendix I.

Species in the family *Cruciferae* are greatly varied and are found to be distributed throughout the world. However, many of them are naturally well adapted to so-called 'Mediterranean climate' which is characterized by showing distinct, alternating, dry and wet seasons. Their seeds germinate early in the

wet season which usually begins in the fall and they grow in the warm and moist winter. They flower and ripen just before the dry season begins in the middle part of spring. Their mature seeds scattered on the ground from their dehiscing siliqua are preserved safely under the dry-season conditions until they germinate in the beginning of the wet season. The Mediterranean coasts of Europe, Asia Minor, Africa and their islands are naturally their centres of distribution. *Brassica* and allied genera forming the subtribe *Brassicinae* in *Brassiceae* are said to originate in this region. We can, however, find some special cultivated forms of *Brassica* in China and in northern part of India (*B. campestris* and *B. juncea*) and a special allopolyploid species (*B. carinata*) in Ethiopia. Accordingly, the present plant exploration which was made during the period from April 5 to June 20, 1965, was confined to the Mediterranean region above-described, but passing northern India and the Ethiopian plateau on the way.

This is the preliminary report informing the general outline of the exploration, which consists of the following two parts:

Part I. Brief description of the main species collected and their bearing on the human life.

Part II. Diarial description of the progress of the exploration trip.

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Part I. Brief descriptions of the main species collected and their bearing on the human life

A) Cultivated species in *Brassica* and their wild forms

We can firstly mention as the monogenomic cultivated species in *Brassica* *B. nigra* Koch., the black mustard (genome, *B*; n=8), *B. oleracea* L., the cabbage group (*C*, n=9), and *B. campestris* L., the rape and the turnip group (*A*, n=10). As independently proved by Morinaga (2) and U (3), different combinations of two of these three genomes make the three composite genomes of the digenomic, cultivated species, *viz.*, *B. carinata* Braun, the abyssinian mustard (*BC*, n=17), *B. juncea* Hemsel, the mustard (*AB*, n=18), and *B. napus* L., the rape and the swede group (*AC*, n=19).

i) *B. nigra* Koch., the black mustard

In the present trip *B. nigra* was confirmed, as pointed out by Vavilov(4), to be distributed widely throughout the Mediterranean region, the Ethiopian plateau and northern India. It grows mostly wild. Only in Ethiopia, two Aegean islands, Crete and Rhodes, and Sicily, the authors found it cultivated or growing under semi-cultivated conditions. In Turkey it is sometimes used as a spice for flavoring sausage or dressing for salads and some times as an antiseptic for storing beef. In the island, Rhodes, they take its inflorescence boiled and seasoned with salt, lemon juice and olive oil. In Sicily the authors found it grown for medicinal use in the backyard of a farm house. In Japan Dr. K. Furusato, President of the Tropical Botanic Gardens near Shimoda, Shizuoka, first sampled its leaves and confirmed them to be tasty.

ii) *B. oleracea* L., the cabbage group

The cultivated forms of this species such as the common cabbage, the Brussels sprouts, the kale, the cauliflower, and so on, are found cultivated in every country visited.

The authors first found one of the wild forms of this species in the steep slope near the summit of Monte Pellegrino, a rocky mountain overlooking the Bay of Palermo, Sicily. It was a kale-like plant which was identified as *B. rupestris* Rafin. (*B. oleracea* var. *rupestris*) by the kind collaboration of Dr. A. Martino, Professor of systematic botany, University of Palermo. Again in the rocky cliff in one of the Egadi Islands, Favignano, off the coast of Trapani, Sicily, they found some kale-like plants bearing half-ripened gigantic siliqua. They could collect some seeds from these plants which were identified as *B. macrocarpa* Guss. (*B. oleracea* var. *macrocarpa*). In Spain they obtained seed of *B. Robertiana* J. Gay by the courtesy of the Faculty of Pharmacy, Ciudad University, Madrid, which was supposed to be another wild form of *oleracea*.

As a peculiar cultivated form of the species noted for its edible, delicious stem used for Chinese dishes, *B. albograbra* Bailey (*B. oleracea* var. *albograbra*) is

grown in southern China and Taiwan. The authors were successful in collecting its seed in Hong Kong. It is a rare, self-compatible form in the cabbage group and bears white flowers. Seeds of some common cabbage varieties were collected in Egypt and Spain.

iii) *B. campestris* L., the monogenomic rape, the turnip, and other 10-chromosome species in *Brassica*, except *B. Tournefortii* Gouan

In the herbarium of the Royal Kew Botanic Gardens, London, all the 10-chromosome *Brassica* species, except *B. Tournefortii*, which cross freely and give fertile hybrids *inter se* are classified as the varieties of *campestris*. Thus the 10-chromosome rape and the turnip rape (*B. rapa* var. *oleifera*) are likewise assorted as *B. campestris* var. *oleifera*; the turnip (*B. rapa* var. *rapifera*) as *B. campestris* var. *rapifera;* and so on. U(3) and his collaborators including Mizushima used *B. campestris* as the representative name of the 10-chromosome species in *Brassica* which have similar genomes. *B. Tournefortii* has a different genome than that of *campestris* (Sikka, 5; Mizushima, unpublished), which crosses rather difficultly with the latter, giving utterly sterile hybrids. Here the description is made after the classification of the Kew Botanic Gardens.

As a peculair cultivated form we can mention *B. campestris* var. *sarson* which is grown for oil as well as for a leaf vegetable in Punjab State, India. There are two strains of *sarson*, brown and yellow, after their seed coat color. Yellow *sarson* is the only self-compatible variety among those of the *campestris* group. *Sarson* is grown mostly in Up State, Punjab, Utter Pradesh. Another rape variety also grown in Punjab State is *B. campestris* var. *toria* which is cultivated mostly in the province of Amritsar for oil. Both *sarson* and *toria* are sown in September or in October. Toria is harvested in early February next year, being followed by sugar-cane cultivation. *Sarson* is havested about a month later, and sometimes grown mixed with *Triticum*, *Lathyrus*, *Lens*, *Medicago*, or *Trifolium*. Their oil cake is used for a manure or a fodder. When the authors were travelling in Punjab plain they had already been harvested, but in Himachal Pradesh, a province on the outskirts of the Himalayan mountain range, some strains of *saron* were still found in the mountain fields near the towns of Simla and Nahan.

Besides these two, *sarson* and *toria*, the authors collected some other cultivated varieties of *campestris* in Morocco and Egypt which comprised turnip, *B. campestirs* var. *rapifera*, and rape, var. *oleifera*.

An immense area of semi-desert of the Central Plateau of Asia Minor around Ankara was irrigated and wheat was grown. It was indeed a grand view to look at the great expanse of yellow flowers of wild crucifers covering the vast wheat fields as far as the eye could reach. One could easily find there a great colony of wild *campestris* growing as a weed in the field. They were, however, too young to give mature seeds. In Ankara University they kindly furnished the authors with seed of wild *B. napus* collected by them in the Central Plateau, a part of which

might perhaps be that of wild *campestris* and which is now being investigated. Small colonies of seemingly wild *campestris* were found by the mountain road along the European coast of the Strait of Bosporus, at the foot of the extinct volcano, Monte Nuovo, near Naples, and at the bottom of the rocky mountain, Monte Pellegrino, near Palermo, Sicily. The authors are, however, not certain whether they are true wild *campestris* or escaped cultivated varieties.

iv) *B. carinata* Braun, the Abyssinian mustard or the Ethiopian cabbage

Cultivation of *B. carinata* is confined only to a part of the East African Plateau. It is the most popular leaf vegetable taken by Ethiopian people. Its growth duration is so long that they can get leaves from standing plants in the field almost at any time, which they take boiled. Every farmer in Ethiopia grows it and the banana in his vegetable garden. Since this species proved to be the amphidiploid between *B. nigra* and *B. oleracea* and was endemic to the Ethiopian plateau, the authors took special interest in the investigation of its growth habit, distribution and history in comparison with those of the two ancestral, parental species. They also endeavoured to find wild forms of *carinata*. However, as far as the authors' investigations are concerned, its history in Ethiopia is quite obscure and no plant which is considered to be truly wild has been found. From the fact that a kale-like form of the cabbage group and the black mustard have been grown or growing wild in Ethiopia from ancient times, Abyssinian mustard might possibly be originated from hybrids between these.

The authors collected seeds of various strains of *B. carinata* not only in their habitats, but also at the markets in Addis Ababa and Jimma where the native farmers sold seeds of crops produced by them.

v) *B. juncea* Hemsel, the mustard

As already stated, *B. juncea* and allied species, *B. cernua* Coss., are the amphidiploids between *B. campestris* and *B. nigra*. According to Dr. Kamie Karamanoğlu of the University of Ankara, Turkey, their centre of distribution in the Near East is the area covering southern Iraq and the Arabian Peninsula. However, the authors were not able to travel in this area. As far as the present exploration trip is concerned there were found no wild forms of these species in the countries visited. Since they have many cultivated strains of both species in Sendai, they did not introduced any cultivated strains, except one collected in Morocco.

vi) *B. napus* L., the digenomic rape and the swede

This is the amphidiploid between *B. campestris* and *B. oleracea*. There are many strains of its cultivated forms in Japan which were introduced from foreign countries during past fifty years, but almost none of its wild forms. Collection of the latter was, therefore, one of the main purposes of the present trips. However, the authors were not successful to find any wild *napus* throughout the regions passed. As referred to before, the authors obtained seed of a wild *napus* strain by the

courtesy of the University of Ankara, Turkey, which was collected by them in the semidesert near Ankara. The seed, however, resembled closely that of *campestris* in external appearance and it is now being investigated in Sendai. Only one strain of the swede grown in the outskirts of Rabat, Morocco, was introduced.

B) Wild species in *Brassica*

If we regard such a wild species as to have a genome similar to that of a cultivated species and to cross freely with the latter, giving rise to a fertile hybrid, to be a wild form of the latter, then *B. Tournefortii* Gouan was the only purely wild *Brassica* species that has hitherto been grown and continued in Sendai by the authors. In the present trip several other wild species including *B. adpressa* Boiss., *B. fruticulosa* Cyril., *B. Barrelieri* Janka,. *B. valentina* DC., *B. Cheiranthos* Vill., *B. Erucastrum* Poll., and *B. pubesens* Ard., were collected in their habitats or obtained from research institutes in the countries visited. One or two of them might turn out to be a wild form or forms of any cultivated species, but they have never been introduced into Japan and are no doubt precious materials for the study on the evolution genetics of *Brassica* and allied genera in *Brassiceae.*

i) *B. Tournefortii* Gouan

Though this species has ten chromosomes as the haploid complement, its genome proved to be quite different from that of *campestris* (n=10). It crosses difficultly with *campestris* and gives rise to utterly sterile hybrid whose maturation division is very anomalous. It is of xylomorphic form and preferably grows on sandy soils. It proved to be self-compatible. Though Vavilov (4) described its wide distribution throughout the Mediterranean and the Middle Eastern region, the authors barely managed to find its small colony in the coastal desert near Alexandria, Egypt, by the kind collaboration of Prof. V. Täckholm of Cairo University. The plants were already ripe and dry and their sliliqua were about to dehisce. It is supposed, therefore, that the reason why the authors could not find such a wide-distributing species anywhere during the trip may be due to its earliness.

It is said that *B. Tournefortii* is used as a medicinal plant in India.

ii) *B. adpressa* Boiss.

The synonyms of this species are *Hirschfeldia incana, H. adpressa* and *Sinapis incana.* It has the lowest number of chromosomes (n=7) in *Brassica.* It is one of the most popular species in the Mediterranean region and is found ordinarily by the roadside and in waste lands. It is even thriving among the stone debris in the ancient Greek, Carthage and Roman ruins found in the region. The authors collected its seeds everywhere on the Mediterranean coasts and in the islands visited. It is found mostly to be a dominant species in a barren soil.

iii) *B. fruticulosa* Cyril.

The authors found this species in the slope and on the fringe of the crater of an extinct volcano, Monte Nuovo, on the outskirts of Naples, Italy. Schulz (1) describes

that it preferably grows in gypsum-rich soils. Mizushima(unpublished) has confirmed it to be n=8. It shows quite different morphology and growth habit from those of *B. nigra* (n=8) and is expected to have a different genome from that of the latter.

iv) *B. Barrelieri* Janka.

This species is characterized to bear a larger silique than other wild species in *Brassica*. It was found by the roadside and in a fallow field along the Atlantic coast between Casablanca and Rabat, Morocco, and also in a waste land in the outskirts of Madrid, Spain.

v) *B. pubesens* Ard.

Sinapis pubesens is supposed to be the synonym of *B. pubesens*. It was collected by the wayside of the up-hill route near the summit of a rocky mountain, Monte Pellegrino, overlooking the Bay of Palermo, Sicily.

vi) *B. valentina* DC.

vii) *B. Erucastrum* Poll.

viii) *B. Cheiranthos* Vill.

The seeds of these species were not collected in their habitats. *B. valentina* was obtained from the Faculty of Pharmacy, Ciudad University, Madrid, and both *B. Erucastrum* and *B. Cheiranthos* from the Botanical Gardens of Madrid.

B. Cheiranthos is known to have the highest number of chromosomes (n=24) of all the natural species in *Brassica*. Dr. I. H. McNaughton of the Scottish Plant Breeding Station, Pentland field, Roslin, Scotland, supposes it to be the amphidiploid between *B. monensis* Huds. (n=12) and *B. Wrightii* Auth. (n=12), the latter two species being endemic to the Island of Great Britain. According to his personal correspondence to one of the authors *B. monensis* is distributed in Scotland Southwest and on the West coast of England and Wales, though not so frequently be found. *B. Wrightii* is endemic to the small Lundy Island at the entrance of Bristol Channel off the north coast of Devnonshire. He kindly sent to the authors seed of *B. monensis* with a letter saying that taking seed of *B. Wrightii* out of Lundy Island was forbidden by several reasons and one who want to have it must personally ask the authority with a statement of reasons.

C) Other species in the tribe *Brassiceae*

Intergeneric hybridization in the tribe *Brassiceae* which includes fifty-two genera was first made by Karpechenko (6) in 1924 between *Brassica* and *Raphanus*, leading to the formation of the first artificial amphidiploid, *Raphanobrassica* (7). Various hybrids obtained from different generic combinations were reported by U *et al.* (8) and Mizushima (9) among *Brassica*, *Sinapis*, *Eruca* and *Raphanus*. Recently Mizushima and his collaborators were successful in crossing *Brassica* with *Diplotaxis* (Mizushima *et al.*, unpublished). It has been observed that at MI in the microsporogenesis in each of the intergeneric hybrids from these crosses there appear always a certain number of gemini due to allosyndeses between the

member chromosomes of the two different genomes concerned (Haga, 10; Fukushima, 11; Mizushima, 9). The fact, together with their continuous chromosome numbers, show obviously that these genomes are of secondary polyploid nature, which have been derived from a common original genome (Mizushima, 9). Since, the species in this tribe are of great importance in elucidating the species formation in *Brassica* and allied genera.

i) *Sinapis spp.*, the white mustard group

The genus *Sinapis* is considered by several taxonomists to be the synonym of *Brassica*. In the herbarium of Kew Botanic Gardens, London, all the species of *Sinapis* are also labelled as those of *Brassica*. It was observed by Mizushima (9) that in the microsporogenesis in F_1 of the cross *B. nigra* (n=8) × *Sinapis arvensis* (n=9) as many as eight gemini, mostly eight bivalents and rarely one trivalent and seven bivalents, were formed by the allosyndetic union between the member chromosomes of the two genomes, showing a remarkably close evolutional relation between them. From the karyogenetic as well as the morphological viewpoints we may rightly say that *Sinapis* is the synonym of *Brassica*.

In the present trip various strains of *S. alba* Rabh. (*B. alba*, n=12) and of *S. arvensis* L. (*B. arvensis=B. Sinapistrum*, n=9) were collected. *S. alba* is cultivated for table mustard, but its wild form is not rare. Both the species are distributed widely throughout the Mediterranean region and are found sometimes as weeds in wheat fields and sometimes by the roadside or in the fringe of meadows, forming colonies of various size. Besides, some strains of *S. turgida* Del. (*B. turgida*, n=?) were collected which were found growing as weeds in barley fields in the reclaimed desert in Taharir Province, Egypt. There are two varieties of *S. turgida*, *tipica* and *leocarpa*, the former being hispid and the latter glabrous.

ii) *Diplotaxis spp.*

This is also a closely related genus to *Brassica*. It belongs to the subtribe *Brassicinae* which includes 11 genera such as *Brassica*, *Sinapis*, *Eruca*, *Erucastrum*, and so on. Recently crosses between *Diplotaxis* and *Brassica* have been made successfully in the authors' laboratory. The species involved in the crosses were *D. tenuifolia* DC. and *D. erucoides* DC. which have been grown hitherto in Sendai. The newly introduced species by the present trip are *D. catholica* DC., *D. acris* Boiss., *D. Harra* Boiss., *D. Lagascana* Willk., *D. siifolia* Kunze, *D. tenuisiliqua* Delile and *D. virgata* DC. Besides these, some new strains of *erucoides* and *tenuifolia* were also introduced. All of them are wild species which are distributed quite widely in the Mediterranean region. They are found almost everywhere by the roadside, in green fields, in meadows and in waste lands. One of them, *D. Harra*, is observed to be highly drought resistant, being found thriving in Egyptian 'Wadi', a desert valley retaining some moisture.

Leaves of *D. tenuifolia* chopped and mixed with lettuce are taken as salad in Greece and Turkey for their peculiar fragrance.

iii) *Eruca spp.*

The representative species of this genus is *E. sativa* Mill., the garden rocket, which is grown in some European countries for salad. In Punjab State, India, it grows wild or under semi-cultivated condition, which they use as a fooder for cows. It is sometimes grown for oil in Turkey. The authors have been growing some of its strains introduced from northern Europe in Sendai. In this trip they could collect many of its wild forms being distributed in India and the Mediterranean region. They usually form a colony of various size by the roadside, in fields and in waste lands. They even thrive among the stone debris of ancient ruins of Acropolis, Athens, and of Knossos, Crete. From its habitats stretching frequently into shady places, *E. sativa* is supposed to be more tolerant of weaker illumination than *Brassica adpressa.* Besides *E. sativa*, the authors collected other three wild species, *E. longirostris* Uechtr., *E. orthosepara* Lange and *E. vesicaria* Cav., whose seeds were generously offered by the Faculty of Pharmacy, Ciudad University, Madrid, Spain.

iv) *Erucastrum spp.*

Erucastrum is the synonym of *Hirschfeldia* (Manton, 12) and both are now regarded as the synonyms of *Brassica.* Thus in the Royal Kew Botanic Gardens, London, the species of *Erucastrum*, are classified as those of *Brassica.* It is, however, noticeable that the number of chromosomes observed in five of the species in *Erucastrum* is either n=15 or 16, the numbers having never been found in old *Brassica* species. The fundamental number, 16, for the genus is the highest yet known in *Cruciferae* which Manton (12) considers to be of tetraploid origin on 8. The other one, 15, he suggests, is almost certainly to be derived by loss of one chromosome from the former.

The authors have introduced four of its wild species, *E. arabicum* Fisch. & Mey., *E. incanum* Koch, *E. laevigatum* Schulz and *E. nasturtiifolium* Schulz, the first being obtained in Ethiopia and the other three in Spain. Of these *E. arabicum* is said to be the synonym of *B. Schimperi* Auth. and *E. incanum* that of *B. adpressa.*

v) *Raphanus* spp.

Raphanus belongs to the subtribe *Raphaniae* in *Brassiceae*, which comprises 18 genera such as *Reboudia, Morisia, Rapistrum, Cakile, Crambe, Calepia, Cossonia*, and so on (Schulz, 1). *R. sativus* L. is the only cultivated species in this genus. Many strains of its wild form and of *R. raphanistrum* were collected in the present trip. They show remarkably wide distribution in the Mediterranean region. They are observed to prefer growing in sandy soils, but it is not rare to find them thriving by the roadside, in fallow fields and in waste lands. Creeping forms of *R. raphanistrum* were found frequently in the coastal sand. There were found two varieties of *raphanistrum, typica* and *landra*, the former bearing white and the latter yellow flowers.

vi) *Crambe* spp.

Crambe is noted to include species having the highest number of chromosomes (n=60) yet found in *Cruciferae*. An obvious polyploid series is observed in the genus, whose fundamental number is 15. Manton suggests that this fundamental number might probably be derived by aneuploid loss from a tetraploid on 8 (n=16) as seen in *Erucastrum*. *C. abyssinica* Hoch. (n=45) has been the only species introduced hitherto into Sendai. The authors were not successful in collecting wild *Crambe* species in their habitats during their trip, because it was too late in the coastal region and too early in inland Asia Minor to get mature seeds from them. However, they were able to obtain seeds of five species, *C. cordifolia* Stev., *C. maritima* L., *C. orientalis* L., *C. tatarica* Sebeok and *C. hispanica* L., by the courtesies of several research institutes in Spain, Turkey and Ethiopia. Of these *C. maritima* which is indigenous to the coasts of Europe and known as the sea-kale is cultivated for its young shoots and unfolded leaves used as spring vegetables. Recently they are trying to grow *C. abyssinica* for oil in the United States and Canada. The authors might be able to separate seeds of some wild *Crambe* species growing in Ethiopia from those of *B. carinata* which were obtained from native farmers in Addis Ababa, Jimma, and Waliso markets, and which were likely to contain wild *Crambe* seeds as impurities.

v) *Enarthrocarpus spp.*

This also belongs to the subtribe *Raphaniae*. Two of its species, *E. pterocarpus* DC. and *E. strangulatus* Boiss., were found growing wild in the irrigated desert fields in Taharir Province near Alexandria, Egypt. They already ripened and were dry, but showing obvious xylomorphic nature. Their siliqua are not dehiscent and are partly lignified, making it very difficult to separate seeds from them.

vi) *Rapistrum rugosum* All.

This is one of the crucifers which show the widest distribution throughout the Mediterranean region. One of its strains was introduced into Sendai some twenty years ago. It is mostly found thriving in waste lands both inland and coastal, frequently forming a large colony. The authors were surprised to see the central strip of land of the superhighway connecting Rome and Florence was covered at places with its yellow flowers. Several of its strains were collected in Turkey, Italy, Algeria, Morocco and Spain.

vii) *Cakile maritima* Scopoli

Hayet (13) classified *Cakile* as a member of the subtribe *Raphaniae*, but Schulz (1) assorted it as the representative genus of the subtribe *Cakilinae* established by him. Several of its strains were collected in Sicily, Tunisia and Spain. It seems to grow preferably in clay-containing sandy soil near seashore.

viii) *Moricandia spp.*

Moricandia belongs to the subtribe *Moricandiinae* which comprises eight genera. Six species including *M. arvensis* DC., *M. bactico* Boiss., *M. clavata* Boiss.,

M. foetida Bourgeau, *M. nitens* Dur. & Barr. and *M. Ramburii* Webb. were collected in Egypt, Italy and Spain. They are ordinarily found thriving under dry conditions. In Egypt they grow in 'Wadi', the desert valleys, and in Italy and Spain in barren lands where water is scarce.

Besides the species above described the authors collected one belonging to the subtribe *Moricandiinae*, three to the subtribe *Vellinae*, and one to the subtribe *Zillinae*, whose names and origin are as follows:

Moricandiinae

Conringia planisiliqua Fisch. & Mey., Spain;

Vellinae

Vella annua L., Spain, *Carrichtera annua* Aschevs., Egypt,
Succowia balearica Medik., Sicily;

Zillinae

Zilla spinosa Prantl., Egypt.

D) Species belonging to other tribes than *Brassiceae*

Various wild crucifers which belong to other tribes were found growing along with the species of *Brassiceae* in the course of the trip. Though they were not the objects of the present trip, investigation of their distribution was made in comparison with that of the species of *Brassiceae*. The following are the brief notes about the main species which showed wide distribution.

Species of the five genera, *viz.*, *Alyssum*, *Capsella*, *Lepidium*, *Matthiola* and *Sisymbrium*, were found the most frequently in the Mediterranean region. Among them *Capsella bursa-pastoris* Medik., *Sisymbrium Irio* L. and *S. officinale* Scop. are the commonest species throughout the region. They thrive mostly in waste lands and by the roadside and are found frequently to be dominant species. It was noticed that *S. Irio* was mostly found near human habitation. *C. bursa-pastoris* which is the commonest wild crucifer in Japan is also the commonest one in northern India and the Mediterraean region. A great number of its strains growing at different localities throughout its vast distributing area might make one of the most favorable materials for the studies on genecology. *Alyssum* species such as *A. campestre* L., *A. maritimum* Lamark and *A. psilocarpum* Boiss. are usually found in sandy soils. *Lepidium draba* L. seems to grow preferably in humid places such as the brink of a stream and of an irrigation cannal. *Matthiola livida* DC. looks highly drought-resistant. It thrives in the 'Wadi' in the Egyptian desert. It is said that a species of *Lepidium*, *L. sativa* L., is used for medicinal purpose in Ethiopia.

Part II. Diarial description of the progress of the exploration trip

A) Hong Kong, April 3~4, 1965

The authors stayed in Hong Kong only for twenty hours. They made a short trip in the suburbs of Kowloon to investigate the cultivation of *Brassica albograbra* and wild crucifers thriving there. *B. albograbra* is a white-flowered, self-compatible variety of *B. oleracea*, the cabbage group, which is exclusively grown in southern China and Taiwan for its stem used for Chinese cooking. It was, however, out of its growing season then and they only obtained its seeds from a farmer together with those of some cultivated crucifers which could not be identified exactly. As far as their short trip was concerned, no wild crucifers belonging to the tribe *Brassiceae* were found there at that time.

B) India, April 4~9

The plain of Punjab State was already in the dry season and almost no crucifers, both cultivated and wild, were growing there. After the suggestion and by the cooperation of Dr. H.B. Singh, Head of the Plant Introduction Division, Indian Agricultural Research Institute (I.A.R.I.), and by the help of the Japanese Embassy, New Delhi, an exploration trip was made in Himachal Pradesh, a province at the foot of the Himalayan mountain range, especially in the areas around Simla and Nahan where some crucifers still grew owing to the climatic lag due to the high altitude (*ca* 7,000 ft. above sea-level at Simla). By the assistance of Mr. S.A. Dadlani, Head of the Plant Introduction Subdivision, I.A.R.I., Simla, who guided the authors during two day's trip from Simla to Chandigarh via Nahan, they were successful to collect seeds of *Brassica campestris* var. *sarson* grown in some terraced fields in the mountain slopes. They also obtained seeds of *B. campestris* var. *toria* from local farmers. Besides, they found at places small colonies of *Eruca* species thriving by the mountain roadside. There were two forms, glabrous and pubescent, but they were identified as varieties of *E. sativa*. The authors were not certain whether they were wild strains or escapes from cultivation, because both the forms were found cultivated in a field near Nahan. *E. sativa*, both wild and cultivated, is used as a fodder for the cattle in India.

C) Ethiopia, April 10–17

There are three different seasons in respect to the rainfall in the part of the Ethiopian Plateau around Addis Ababa, *viz.*, the small rain season (from February to April or May), the big rain season (from June to September) and the dry season (from October to January). The wild plants there generally flower in September and mature in October. It was, therefore, not the proper time to collect seeds of wild plants there when the authors arrived in Addis Ababa. However, there is another part of the plateau where no such clearcut seasonal changes occur and the

field is always green due to proper rainfalls throughout the year. Such is Kaffa Province (Coffee Province) whose capital is Jimma being located *ca.* 200 miles southwest of Addis Ababa across the valley of River Gibbe. The province is said to be the place of origin of the coffee plant.

After the schedule made by the suggestion of Dr. H. F. Rouk of USAID and Mr. G. W. Ulenbroek of the FAO Representative Office in Addis Ababa three days' exploration was made along the route, Addis Ababa — Waliso — Jimma. Mr. Lemma Gebra-Selassie, plant taxonomist, Haile-Selassie I University, accompanied as a collaborator and an interpreter. The main purpose of the trip was to investigate the distribution of the wild forms of *Brassica carinata* and its ancestral, parental species, *B. nigra* and *B. oleracea*, and to collect their seeds. The former is, as stated, the natural amphidiploid between the latter two species.

B. nigra was found as a weed of vegetable gardens in Waliso and Jimma area. According to Mr. Lemma, *B. nigra* grows wildly also in the bushes in the plateau, though it is often cultivated for medicinal use. However, as far as the authors' investigation was concerned, no wild strains of *B. oleracea* and *B. carinata* were found. There were two varieties of *B. oleracea*, var. *acephala*, the kale, and var. *capitata*, the common cabbage, cultivated in Ethiopia. The kale has been grown from ancient times, whereas the common cabbage is said to have been introduced into this country during the Italian occupation in 1936. As described before, wild varities of *B. oleracea* were always found in a rocky cliff on the seashore in the Mediterranean region. It may, therefore, be natural that none of them was found in the plateau lacking such a place. *B. carinata* which is called the Ethiopian cabbage or the Abyssinian mustard is endemic to the plateau and is the most popular leaf vegetable taken by the Ethiopian peopole. It is grown everywhere by the native farmers along with the banana. It is sometimes found growing under wild conditions, but investigation always reveals that it is an escape from cultivation. No strain which is supposed to be truly wild is found. Its history in Ethiopia is quite vague and it is not certain whether it was introduced from outside and now only remains in the plateau or it originated in the plateau from the hybridization between wild *nigra* and cultivated *oleracea*.

It was then the seeding season for the year in the plateau. In the market in each town the farmers were selling seeds of crops produced by them. The authors could obtain seeds of the cultivated crucifers including *carinata*, *nigra*, *oleracea* and *Lepidium sativa* in the markets in Jimma, Waliso and Addis Ababa, the last species being grown for medicinal use. Besides, they got seeds of peculiar crops grown in Ethiopia whose names are shown in Appendix II.

D) Egypt, April 17–23

The authors were surprised to see that the extensive area of Cario Airport was covered at places with yellow flowers of wild crucifers as their plane was lowering

its altitude for landing there. They realized that they were beginning to enter the centre of distribution of cruciferous plants.

All necessary arrangments for the authors' investigation trip in Egypt were made beforehand by the kind cooperation of Dr. W.A. Warid, College of Agriculture, Kahera University, and staffs of the Ministry of Agriculture and Forestry of UAR. After making arrangments as to the schedule of the trip with Prof. Vivi Täckholm, College of Science, Kahera University, and Mr. Mohamed Hussein Ismail, Director of the Herbarium Section, Cairo-Dokki Agricultural Museum, Ministry of Agriculture and Forestry, the authors went to Wadi Degla in the desert on the southwestern outskirts of Cairo. Dr. Warid, Mrs. V. Holmen, Prof. Täckholm's assistant, Mr. Hussein and Mr. A. Khattab, a staff of the Agricultural Museum went toegther as collaborators. Wadi is an Egyptian word meaning a desert valley where some moisture is retained in the soil due to water in natural underground basin. There they found various xylomorphic herbs and shrubs growing sparsely. Among them there were *Diplotaxis Harra*, *D. acris*, *Moricandia clavata*, *Farsetia aegyptiaca*, *Zilla spinosa* and *Matthiola livida*, from which they could collect seeds (Photograph 1).

The same party, except Dr. Warid and Mrs. Holmen, proceeded from Cairo to Alexandria, taking the route along the railway on the delta. On the way they found several wild crucifers which were growing by the roadside, on the ridge of paddy fields, in fallow fields and in waste lands. These species were identified as *Brassica nigra* var. *bracteolata*, *B. rapa* (*B. campestris* var. *rapifera*), *Sinapis arvensis*, *Raphanus sativus* and *Capsella bursa-pastoris*. All of them gave good seeds.

The vast area of the coastal desert near Alexandria was being reclaimed by irrigation and thousands of acres of cultivated and semi-cultivated lands were developing. By the collaboration of Prof. Täckholm and Dr. Warid who came and joined the party the authors were able to make a detailed investigation of the distribution of the wild crucifers thriving there which belonged mostly to the tribe *Brassiceae*. In the semi-cultivated lands in North Ameria area *Sinapis alba*, *Matthiola livida*, *Enarthrocarpus pterocarpus* and *Reboudia microcarpa* were found growing as weeds in the fields. In Ekingi Mariut area *Sisymbrium Irio* was noticed to form fairly large colonies by the roadside near a small group of farmhouses. A small colony of *Lepidium draba* was also found on the brink of an exhausted irrigation canal. Taharir Province, the most improved desert area where large-scaled and pervasive irrigation system was applied, was the richest in the kind of wild crucifers. Besides the above-mentioned species, the authors found there *Erucaria hispanica*, *Moricandia nitens*, *Carrichtera annua*, *Enarthrocarpus strangulatus* and *Sinapis turgida* which grew mostly as weeds in the fields. *Lepidium sativa* was also found thriving by the roadside.

What was especially noteworthy in the trip around Alexandria was the

discovery of a small colony of *Brassica Tournefortii* in the sand dune on the desert coast at Abusir where there were the ruins of ancient Roman town Taposiris Magna and of Cleopatra's palace. This species is said to be distributed quite widely from the Middle East to the Mediterranean region, growing preferably in sandy soils. However, it was the only colony of the species that the authors could locate throughout their trip in the Mediterranean region. The plants found were already ripe and dry, showing their remarkable earliness. If the authors had visited the spot a week later, they would not have been found. From the fact, the reason why such a wide-distributing species as *B. Tournefortii* was not found anywhere in the trip might be due to its earliness. It was supposed from the conditions of the habitat that *B. Tournefortii* was one of the most drought-resistant species in Cruciferae. Besides, colonies of *Matthiola humilis* were found in Abusir.

E) Greece, April 24–May 2

When the authors visited Greece spring was not far advanced in both the mainland and her Aegean islands. Wild crucifers there just reached their flowering time and no mature seeds of them could be collected. Their plant exploration there was, therefore, confined only to the investigation of the kind and the distribution of the crucifers thriving there. The coastal and inland areas around Athens and two Aegean islands, Crete and Rhodes, were investigated. Dr. J. Kelperis, Director, National Institute of Vegetable and Seed Control, Halandrion-Attikis, Athens, offered facilities and made necessary arrangments for their investigation in the mainland as well as in the islands, keeping in contact with the local governmental offices concerned.

Everywhere was yellow with flowers of wild crucifers in both the inland and the coastal suburbs of Athens. There the authors found *Brassica nigra, B. adpressa, Eruca sativa, Sinapis arvensis, S. alba, Lepidium draba, Sisymbrium Irio, S. officinale,* and *Capsella bursa-pastoris* being in full bloom in the fields, on the margin of vineyards and olive fields, and by the promenade along the seashore. Each of them was found frequently forming a simple colony, but sometimes growing as a member of a mixed colony with wild chrysanthemums, poppies and etc. The dominant species in such a colony was usually one of the crucifers or of the chrysanthemums. The commonest species were *B. adpressa* and *E. sativa* which were thriving even on the hillside of Acropolis and among the stone debris of the ancient buildings.

In the trip along the Aegean coast between Ag. Theodori and Voullagmeni the authors especially endeavoured to find wild varieties of *B. oleracea* in rocky cliffs soaring on the seashore. It was, however, too early to locate them owing to their remarkable lateness in flowering.

In Crete they travelled from the European side to the African side (from Iraklion to Messara) across the central part of the island. Crete was observed to

be rich in *Sinapis* species such as *S. alba*, *S. dissecta* and *S. arvensis* which were mostly found growing in waste lands or as weeds in vineyards and olive fields. On a mountain pass not far from Iraklion there were large colonies of *S. dissecta* being in full bloom. Mr. C. Caravelas of the Agricultural Managment Office, Iraklion, who kindly guided the authors in the trip afterwards sent its mature siliqua to them in Sendai, but these turned out to be completely sterile and gave no seed. *B. adpressa* and *E. sativa* were also common in the island. They were found growing even in the ancient ruins of Knossos. Besides, *Matthiola spp.* and *Capsella brursa-pastoris* were found not rarely. They were not successful to locate *B. cretica*, a wild variety of *B. oleracea* endemic to the island, which might be due to the same reason as that in the case of the mainland.

In the island, Rhodes, they went down along the east coast from Rhodes to Lindos, traversed the island from Archanguelos to Kalavarda, and went up along the west coast to Rhodes. Mr. E. Sparides of the Agricultural Directory Office, Rhodes, kindly guided them in the trip. The same kinds of wild crucifers found in the mainland and Crete were noticed to grow in this island, of which *B. adpressa* was the commonest. No wild variety of *B. oleracea* was located either. No new species other than those found in the other places so far visited was noticed. They saw *B. nigra* grown in the backyard of a farmhouse in the village Malona, which was for medicinal use.

F) Turkey, May 3–11

Investigation around Ismir:

The Crop Research and Introduction Centre under joint managment of FAO and Turkish Government was newly established in Ismir-Karşiyaka, which was beginning to carry out its project when the authors visited there. By the instruction of FAO, Rome, Dr. H. Kuckuck, Project Manager, generously offered every facility for their investigation in Ismir area. Dr. C. Regel, Professor, Department of Systematical Botany, Ege University, Ismir, and Dr. B. Devecioğlu, Director, Regional Agricultural Experiment Station, Ismir-Karşiyaka, kindly cooperated with them in their investigation trips. When they visited Dr. Kuckuck in his office they were surprised to see the extensive ground of the institute in which some buildings were still under construction was covered with yellow flowers of wild crucifers. There they found *Brassica adpressa*, *Sinapis arvensis*, *Eruca sativa*, *Raphanus sativus*, *R. raphanistrum*, *Sisymbrium Irio*, *S. officinale*, *S. orientale* and *Capsella bursa-pastoris* in full bloom. They first investigated the coastal area, taking the route from Ismir to Çeşme. Everywhere was yellow with blooming wild crucifers. Besides the species above-mentioned, they found colonies of *Sinapis alba* thriving in the waste lands along the road. All of the species found were too young to give seeds, except an early strain of *S. alba* growing as a weed in a wheat field on the seashore near Çeşme. Among them *B. adpressa* and *R.*

raphanistrum were the most dominant.

In the inland trip along the route, Ismir — Manisa — Turgutle — Sardis, *Diplotaxis tenuifolia, Rapistrum rugosum, Bunias Erucago* and *Alyssum spp.* were found besides the species already mentioned. The dominant species was different in different places. *R. rugosum* was dominant in mountainous area, whereas either *B. adpressa* or *S. arvensis* was dominant in flat area, the latter two species thriving alternatively.

The authors endeavoured to find *B. Tournefortii* in sandy soils near the seashore in Ismir-Karşiyaka, but none was found.

Investigation around Ankara:

By the kind cooperation of the FAO Representative Office in Ankara and the Turkish Ministry of Agriculture the authors were able to make an investigation trip along the route from Ankara to Polatli through the vast, reclaimed, semi-desert area in the central plateau of Asia Minor. Dr. A. Demirliçakmak of the National Institute of Agricultural Research, Ankara, kindly guided them during the trip. Wheat was grown exclusively in the vast rolling expanse of the reclaimed land. Most of the weeds in the wheat fields were wild crucifers which included about seventeen species belonging to the genera, *Brassica, Sinapis, Raphanus, Rapistrum, Sisymbrium, Alyssum, Lepidium,* and *Capsella.* Dr. Demirliçakmak said that extermination of cruciferous weeds was the most serious problem for Turkish agriculture. They were just in full bloom and the fields were yellow as far as the eye could reach. Among them *Brassica campestris* was the most dominant. In some fields its growth overcame that of the wheat, looking as if rape were grown there (Photograph 4). In a swampy strip of land between the road and the wheat fields large colonies of *Lepidium draba* were noticed. There was no mature plant in any of the species found. However, by the courtesy of Dr. K. Karamanoğlu, Professor of the Botanical Institute, Ankara University, the authors could obtain seeds of nearly all of the species collected by him in the plateau around Ankara. The two species, *Brassica adpressa* and *Eruca sativa,* which were quite common in the other places visited were not noticed in the plateau.

Investigation around Istanbul:

Dr. R. Taşam, Director, Regional Agricultral Research Institute, Jeşilkoy, kindly cooperated with the authors. Investigation was made first on the European coast of the Sea of Marmara by the guidance of Mr. I. Uzal of the institute. *Raphanus raphanistrum* and *Rapistrum rugosum* were the most dominant species thriving there. Besides, *Brassica adpressa, Sinapis arvensis, Sisymbrium Irio, S. orientale, S. officinale, Lepidium spp.* and *Capsella bursa-pastoris* were found. Most of them were growing in unoccupied lands among houses near the seashore. *Sisymbrium* species were rather frequent by the roadsides.

In the trip along the European coast of the Bosporus Strait to Kilyos at the

entrance of the Black Sea the same kind of species were noticed to grow by the roadsides, in fallow fields and in waste lands. Again *Raphanus raphanistrum* and *Rapistrum rugosum* were observed to be the most dominant. However, in the sandy beach at Kilyos on the Black Sea only *Raphanus* species, *sativus* and *raphanistrum*, were found to thrive (Photograph 2). By the wayside of the mountain path near Büyükdere small colonies of *Brassica campestris* were noticed. They were of doubtful origin and could not be decided if they were truly wild. All the species found around Istanbul were too young to give seeds.

G) Italy, May 12–21

The investigation trips in the mainland of Italy and Sicily were made by the kind cooperation of FAO, Rome, which offered facilities, gave useful suggestions, and made all necessary arrangments for the authors' trip in each area, making close contact with the research institutes concerned.

Investigation in the mainland:

Investigation was made first in the suburbs of Rome, next in the area along the highway between Rome and Florence, and then in the area along the Appian Way and the Tyrrhenian coast between Rome and Naples. Dr. G. E. Delhove of the Plant-Production and Protection Division, FAO, and Dr. Montelucci, retired proffessor of the Institute of Botany, University of Rome, kindly cooperated with the authors in their investigation around Rome. Dr. Montelucci generously furnished them with seeds of wild crucifers collected by him in the area.

The species found in these areas were *Brassica nigra*, *B. adpressa*, *Sinapis arvensis* (var. *typica* and var. *leocarpa*), *Diplotaxis tenuifolia*, *D. erucoides*, *Sisymbrium orientale*, *S. officinale*, *Raphanus raphanistrum*, *Rapistrum rugosum*, *Lepidium draba*, *Bunias Erucago* and *Capsella bursa-pastoris*. Of these *Raphanus raphanistrum* and *Rapistrum rugosum* were the commonest and the most dominant. They were found everywhere both in inland and coastal areas, forming large colonies in most cases. All the species except *Lepidium draba* were thriving by the roadsides, in unoccupied lands in villages and towns, in waste lands and in fields. *L. draba* was found only in damp grounds by a stream or an irrigation canal.

After arriving at Naples, the authors made investigation in the suburbs of the city with the kind cooperation of the staffs of the Botanical Gardens, University of Naples. There they found *Brassica fruticulosa* for the first time. It was growing in the slope and on the fringe of the crater of Monte Nuovo, a small extinct volcano, on the northern outskirts of Naples. It was also found in a rocky hillside on the seashore between Naples and Cuma. On the foot of Monte Nuovo only two plants of *B. campestris* were found, which were supposed to be escapes from cultivation. In the same place a few plants of *Eruca sativa* still in their rosette stage were noticed.

In Florence the authors visited the famous herbarium of the Botanical

Institute, University of Florence. There they could examine closely its world-wide collection of cruciferous species by the courtesy of Prof. G. Moggi, which was very useful for them in identifying the species collected by them.

Inveistgation in Sicily:

Receiving a letter from FAO, Rome, Dr. A. Martino, Professor of systematic botany, Institute of Botany, University of Palermo, and Dr. M. Sortino, one of his assistants, were waiting at the airport for the authors to arrive. The three days' investigation trip in Sicily was made successfully by their kind cooperation.

They took the route along the north coast from Palermo to Trapani, went down along the west and the southwest coast to Agrigento, and went back to Palermo via Caltanissetta, traversing the mountainous central part of the island. On the way to Trapani they ascended Monte Pellegrino, a rocky mountain soaring on the seashore of the Bay of Palermo, where they found for the first time in their investigation trips one of the wild variety of the cabbage group, *Brassica oleracea* var. *rupestris* in a rocky cliff near the summit, which bore green siliqua containing immature seeds. By the side of the mountain road *B. campestris*, *B. pubesens*, *Sisymbrium officinale*, *Biscutella didyma*, *Alyssum maritimum* and *Capsella bursa-pastoris* were noticed. Most of them were in their flowering stage. In waste lands on the seashore and by the raodside along the north coast such species as *B. adpressa*, *Raphanus raphanistrum*, *Rapistrum rugosum*, *S. officinale*, *S. Irio*, *Diplotaxis erucoides* and *Cakile maritima* were thriving. *C. maritima* was noticed to grow preferably in clayey sandy soil adjacent to the seashore. Again most of them were too young to give seeds.

From Trapani they took a ferry to one of the Egadi Islands, Favignano, where they found *B. oleracea* var. *macrocarpa*, another wild strain of the cabbage group. The plants were rather few and grew scattered in a steep rocky cliff, showing their perenniality and rare propagation through seed. They were half-ripened and bore gigantic siliqua as its name imparted. (Photograph 3). In the same island *B. adpressa*, *D. erucoides*, *S. officinale* and *R. rugosum* were noticed to thrive in flat area whose clayey soil was very rich in gravel. Plants of a small, prostrate, wild crucifer, *Coronopus procumbens*, were also noticed blooming in a damp ground near the seashore.

In the area along the west and the southwest coast between Trapani and Agrigento *B. adpressa*, *D. erucoides*, *S. officinale* and *R. rugosum* were thriving by the roadsides and in fields and waste lands, of which *B. adpressa* was the most dominant. In a field near the village Castelvetrano they saw *B. nigra* under cultivated condition, which was probably for medicinal use.

In the waste lands along the mountain road leading from Agrigento to the village Canicatti big colonies of *D. Harra* var. *typica* were found, which gave abundant good seeds. By the ditch running along the same road colonies of *Lepidium draba* were noticed and in clayey soil on the mountain side of the ditch *S. arvensis* and *R.*

rugosum were growing alternatively. In the area along the road between Canicatti and Caltanissetta *D. Harra* var. *crassifolia* and *D. tenuifolia* were noticed to be especially abundant. In a stony waste land of clayey soil on a hill near Caltanissetta the two species, *D. Harra* and *Moricandia arvensis*, were exclusively found. From the remarkably dry conditions of their habitat both the species are considered to be highly drought-resistant or xylomorphic.

In the area along the mountain road in the central part of the island wild crucifers were rather rare and no different species from those already mentioned was found.

H) Tunisia, May 22–23

During forty-eight hours' stay in Tunis the authors spent most of the time for taking a rest, making only a short investigation trip in the coastal area between Tunis and Carthage. The season there was far ahead of that in southern Europe and most of the early-flowering wild curcifers were found no more. Even *Brassica adpressa* which was very late in maturity and whose seeds were difficult to collect until then in the southern coastal areas in Europe already ripened and gave abundant mature seeds. It was the most dominant species in the area, thriving everywhere by the roadsides, in waste lands and in unoccupied lands in towns. The other species noticed were *Sisymbrium Irio* and *Cakile maritima*, the former growing mostly by the roadside and the latter in clayey sandy soils adjacent to the seashore and being still in full bloom.

I) Algeria, May 24–25

After visiting the Agricultural Institute of Algeria, Alger, to observe the living specimens of crucifers grown there, the authors made an investigation trip in the area around Alger. The season there seemed not to be so advanced as that in Tunis and such species as *Brassica adpressa, Diplotaxis tenuisiliqua, Rapistrum rugosum, Sisymbrium officinale* and *Capsella bursa-pastoris* were still in bloom. So far as the trip was concerned, no other species was noticed.

J) Morocco, May 26–28

Investigation was made in the area along the Atlantic coast between Casablanca and Rabat. The seasonal conditions in the area seemed to be the same as those around Alger. In a wide unoccupied land on the edge of Casablanca large colonies of *Raphanus sativus* and *R. raphanistrum* were found in half ripened state. *Sisymbrium officinale* was noticed frequently by the roadside. In a fallow field near Bouznika *Brassica*-like plants with ripened siliqua and a few dried upper leaves were found, which could not be identified readily. Later, by the cooperation of the staffs of the National Institute of Agricultural Research, Rabat, they were identified as *Brassica Barrelieri* which had never been collected until then. Another new species collected was *Diplotaxis catholica* which was growing in a waste

land along the road. In sandy soils near the seashore colonies of *Cakile maritima* being still in bloom were noticed. Besides, *B. adpressa* and *D. tenuisiliqua* were found frequently growing by the roadside. In the trip large colonies of wild carrot bearing big blooming umbels in the waste lands along the seashore especially attracted the authors' notice.

In the investigation around Rabat *B. Barrelieri* was again found in a waste land and in a river-beach near the town Sale. Besides the species already mentioned there were found *Sinapis alba* and *S. arvensis* which already ripened.

K) Spain, May 29–June 6

Prof. S. R. Goday, plant taxonomist, Faculty of Pharmacy, Ciudad University, Madrid, and Dr. G. Borja, one of his assistants and also one of the staffs of the Madrid Botanical Gardens, kindly cooperated with the authors and gave useful suggestions for their trip around Madrid and in the island Mallorca.

Even in the city of Madrid there were found various wild crucifers. In the extensive university campus, in the greenbelts along the road outside the campus, and in the immense park, Casa de Campo, such species as *Brassica adpressa, Diplotaxis erucoides, Sisymbrium Irio, S. orientale* and *Capsella bursa-pastoris* were in bloom. Investigation was made in the suburbs of Madrid, especially in the area along the road leading to Villacastin. *Diplotaxis* species were frequent in each localities exmained, which comprised *catholica, erucoides* and *virgata*, the last one was collected for the first time in this trip. They were found mostly growing by the wayside between pastures. *Alyssum* species were noticed also frequently. Among them *A. campestre* was the new one. *Brassica Barrelieri* was noticed in waste lands, but not so frequently. *B. adpressa* and *Sisymbrium* species found in the city were also common.

When the authors visited the Faculty of Pharmacy, Ciudad University, and Madrid Botanical Gardens they kindly furnished the authors with seeds of wild crucifers collected by them throughout Spain. Among them there were eighteen species belonging to the tribe *Brassiceae* whose names were as follows:

Brassica Cheiranthos, B. Erucastrum, B. Robertiana, B. valentina, Diplotaxis Lagascana, D. siifolia, Erucastrum nasturtiifolium, E. laevigatum, E. incanum, Eruca longirostris, E. orthosepara, Crambe maritima, C. cordifolia, Raphanus maritimus, Moricandia Ramburii, M. bactico, M. foetida, Vella annua.

None of these had been collected in the trips made so far.

After the investigation around Madrid the authors flew to Palma in Mallorca, the largest of the Balearic Islands about 115 miles off the east coast of the mainland. The purpose was to collect one of the wild varieties of the cabbage group, *B. oleracea* var. *balearica*, endemic to the island.

On the way they stopped overnight in Barcelona and made a short investigation trip in the suburbs on the mountain side of the city. No new species was

noticed, but only *B. adpressa*, *Sisymbrium spp.* and *Lepidium spp.* were found to thrive there.

In Mallorca they investigated the western part of the island, travelling along the south coast from Palma to Andraitx, then to Puerto de Sóller along the northwest coast, and back to Palma through the mountain road via Buñola. The season there was far ahead of that in the mainland. It was already summer and people were enjoying seabathing. Early-flowering wild crucifers were already gone and none of them were noticed there, except some mature plants of *Sinapis arvensis* found in a waste land near a sandy beach. Only some late strains of *Diplotaxis* and *Sisymbrium* species and *Rapistrum rugosum* were noticed, which were about to ripen.

Along the northwest coast is a mountain range whose skirts make rocky bluffs on the seashore, presenting sutiable environment for a wild *oleracea* variety to grow. However, in spite of the authors' endeavours, they were not successful to find it. It might perhaps be due to its being past flowering and difficult to be found or to its habitat being confined to a certain locality in the island.

L) Corsica, June 7-10

Corsica was the terminal of the authors' plant exploration trip. The investigation in the island was made in the area along the west coast between Sartène and Porto. In sandy beaches colonies of prostrate *Raphanus maritimus* and *Bunias orientalis* were frequently found. Most of the plants of the former were already in thier maturity and those of the latter were still in their blooming stage. In waste lands along the road *Brassica adpressa*, *Raphanus raphanistrum* and *Sisymbrium officinale* were commonly noticed. Most of them were in their maturity. There were many rocky bluffs in the area, especially on the coast between Ajaccio and Porto. They endeavoured to find a wild variety of *B. oleracea* in those bluffs, but again they were not successful.

M) London, June 11–16

During their stay in London, the authors spent most of the time in the Herbarium of the Royal Kew Botanic Gardens. By the kind help of the staffs of the institute they were able to observe every herbarium of the species and varieties of the tribe *Brassiceae* that had been collected throughout the world. They took pictures of all the type specimens and various important species and varieties for the identification of the species collected by them. They could also investigate the living specimens grown there, but these consisted of comparatively few species of *Brassica* and allied genera.

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APPENDIX 1

LIST OF THE CRUCIFEROUS PLANTS COLLECTED BY THE SQUAD OF PLANT EXPLORATION OF TOHOKU UNIVERSITY DURING THE PERIOD FROM APRIL 3 TO JUNE 11, 1965

SPECIES	NUMBER OF STRAINS	ORIGIN
Alliaria officinalis Andrz.	1	Spain
Alyssum campestre Linn.	2	Spain
A. maritimum Lamark	1	Spain
A. psilocarpum Boiss.	1	Spain
Arabis alpina Linn.	1	Ethiopia
Biscutela auriculata	1	Algeria
Borieasa orientalis	1	Italy
**Brassica adpressa* Boiss.	8	Sicily, Tunisia, Morocco, Spain
B. Barrelieri Janka.	4	Morocco, Spain
B. campestris Linn.	9	Egypt, Morocco
var. *toria*	4	India
var. *sarson*	21	India
B. carinata Braun	15	Ethiopia
B. Cheiranthos Vill.	1	Spain
B. Erucastrum Poll.	1	Spain
B. fruticulosa Cyril.	4	Italy, Spain
B. juncea Coss.	1	Morocco
B. macrocarpa Guss.	2	Sicily
B. napus Linn.	5	Turkey, Morocco, Spain
B. nigra Koch.	18	Ethiopia, Egypt, Trukey, Italy, Spain, Morocco
B. oleracea Linn.	3	Egypt, Spain
B. pubesens Ard.	1	Sicily
B. Robertiana J. Gay	1	Spain
B. rupestris Rafin.	2	Sicily
B. Tournefortii Gouan	5	Egypt, Spain
B. valentina DC.	1	Spain
Buuias orientalis Linn.	2	Corsica, Turkey
**Cakile maritima* Scopoli	3	Sicily, Tunisia, Spain
Camelina rumelica Velen.	1	Turkey
Capsella bursa-pastoris Medik.	14	India, Egypt, Greece, Turkey, Sicily, Algeria, Spain
Cardamine hirsuta Linn.	1	Ethiopia
C. obliqua Hochst.	1	Ethiopia
C. trichocarpa Hochst	1	Ethiopia
**Carrichtera annua* Aschevs.	1	Egypt
**Conringia planisiliqua* Fisch. & Mey.	1	Turkey
Coronopus didymus Smith	1	Ethiopia
**Crambe cordifolia* Stev.	1	Spain
C. hispanica Linn.	1	Ethiopia
C. maritima Linn.	1	Spain
C. orientalis Linn.	1	Turkey
C. tatarica Sebeok	1	Turkey

SPECIES	NUMBER OF STRAINS	ORIGIN
**Diplotaxis acris* Boiss.	2	Egypt
D. catholica DC.	4	Morocco, Spain
D. erucoides DC.	5	Italy, Sicily
D. Harra Boiss.	4	Egypt, Sicily
D. Lagascana Willk.	1	Spain
D. siifolia Kunze	1	Spain
D. tenuifolia DC.	2	Italy, Spain
D. tenuisiliqua Delile	2	Algeria, Morocco
D. virgata DC.	3	Spain
**Enarthrocarpus pterocarpus* DC.	1	Egypt
E. strangulatus Boiss.	1	Egypt
**Eruca longirostris* Uechtr.	1	Spain
E. orthosepara Lange	1	Spain
E. sativa Mill.	17	India, Egypt, Greece, Turkey, Italy, Morocco, Spain
E. vesicaria Cav.	2	Spain
**Erucaria hispanica* Druce	2	Egypt
**Erucastrum arabicum* Fisch. & Mey.	1	Ethiopia
E. incanum Koch	1	Spain
E. laevigatum Schulz	1	Spain
E. nasturtiifolium Schulz	1	Spain
Erysimum cumpitlakum DC.	1	Turkey
E. cuspidatum DC.	1	Turkey
E. linifolium J. Gay	1	Spain
E. repandum Linn.	1	Spain
Eusomodendron Bourgeanum Coss.	1	Spain
Farsetia aegyptiaca Turra	2	Egypt
Isatis tincotria Linn.	1	Spain
Lepidium campertre R. Br.	1	Spain
L. draba Linn.	5	Egypt, Italy, Sicily, Spain
L. graminifolium Linn.	1	Spain
L. sativum Linn.	4	Ethiopia, Egypt
L. subulatum Linn.	1	Spain
Malcolmia africana R. Br.	1	Spain
M. littorea R. Br.	1	Spain
Matthiola erlangeriana Engl. & Deser.	1	Ethiopia
M. humilis DC.	2	Egypt
M. livida DC.	2	Egypt
M. parviflora R. Br.	1	Spain
M. tristis R. Br.	1	Spain
**Moricandia arvensis* DC.	5	Italy, Sicily, Spain
M. bactico Boiss.	1	Spain
M. clavata Boiss.	5	Egypt
M. foetida Bourgeau	1	Spain
M. nitens Dur. & Barr.	1	Egypt
M. Ramburii Webb.	1	Spain
**Raphanus chinensis* Thumb.	1	Italy
R. maritimus Smith	1	Spain
R. raphanistrum Linn.	8	Egypt, Sicily, Spain, Corsica
R. sativus Linn.	8	India, Egypt, Greece, Turkey
**Rapistrum rugosum* All.	8	Turkey, Italy, Sicily, Algeria Morocco, Spain

SPECIES	NUMBER OF STRAINS	ORIGIN
Roripa cryptantha A. Rich	1	Ethiopia
R. madagascariensis DC.	1	Ethiopia
R. Nasturtium-aquatica Spoach	2	Ethiopia, Spain
**Sinapis alba* Linn.	9	Egypt, Greece, Turkey, Italy, Morocco
S. arvensis Linn.	10	Egypt, Turkey, Italy, Sicily, Morocco, Spain, Mallorca
S. turgida Delile	1	Egypt
Sisymbrium austriacum Jacq.	1	Spain
S. columnae Koch	1	Spain
S. contoxtum	1	Spain
S. crassifolium Cav.	1	Spain
S. erysimoedes Desf.	1	Spain
S. Irio Linn.	9	Egypt, Greece, Sicily, Tunisia, Spain
S. lagascae Amo.	1	Spain
S. officinale Scop.	5	Ethiopia' Sicily, Morocco, Spain, Mallorca
S. orientale Linn.	2	Spain
S. pinnatifidum Forsk.	1	Spain
S. polyceratium Linn.	1	Spain
**Succowia balearica* Medik.	1	Sicily
Thlaspi olveri Oliv. & Engl.	1	Ethiopia
**Vella annua* Linn.	1	Spain
**Zilla spinosa* Prantl.	1	Egypt

* Genera belonging to the tribe *Brassiceae*

APPENDIX 2

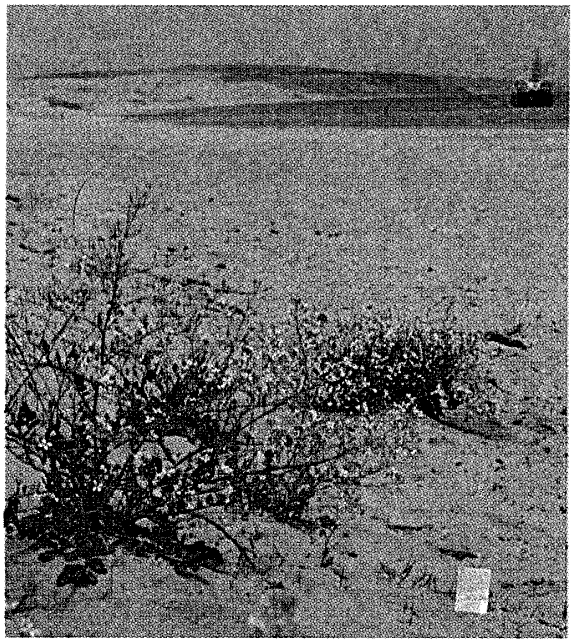
LIST OF USEFUL PLANTS IN ETHIOPIA COLLECTED IN ADDIS ABABA, JIMMA AND WARISO MARKETS BY THE SQUAD OF PLANT EXPLORATION OF TOHOKU UNIVERSITY

COMPOSITAE	
Carthamus tinctorius Linn.* Suf or Yahaya-suf** Safflower***	Oil, food and dye
Guizotia abyssinica Cass. Nug Niger oil or rantil	Oil
CRUCIFERAE	
Brassica carinata Br. Guomin Ethiopian cabbage	Vegetable and oil
Brassica nigra Koch. var. *abyssinica* Br. Sanafitch Black mustard	Medicine
Lepidium sativum Linn. Fechio or fetho Cress or garden cress	Medicine
GRAMINEAE	
Eleusine corocana (Linn.) Gaertn. Dagusa Small or finger millet	Beer (second best) and bread
Eragrostis abyssinica (Jacq.) Link. T'ef Tef	Bread (the most preferred grain for injera, the Ethiopian national bread) and beer (third best). Straw is used for building purposes, as fodder and bedding for cattle, and as nests for chickens.
Hordium vulgare Linn. Sadist-feres Barley	Beer (the most preferred grain for t'ela, beer) and bread
Sorghum vulgare Linn. Mashilla Greater millet	Bread, beer (forth best) and feed
Triticum sp. (*Triticum abyssinicum* ?) Sindi Wheat	Bread
Zea mays Linn. Bakalo Maize	Silage, feed grain, food and beer (fifth best)
LEGUMINOSAE	
Cicer arietimum Linn. Shimbera	Food

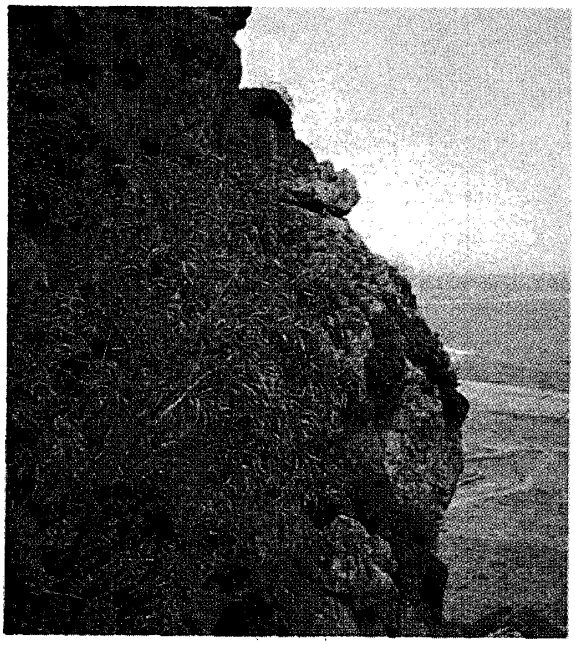
Chick pea	
Lathyrus sativus Linn. Gwaya Lathyrus pea	Food
Lens culinaris Medic. sym. *L. esculenta* Moench. Ades, messer, or misser Lentil	Food
Pisum sativum Linn. var. *abyssinicum* Ater Field pea	Food
Trigonella foenum-graecum Linn. Abish Fenugreek	Medicine
LINACEAE	
Linum usitatissimum Linn. Talba or telba Linseed or flax	Drink and medicine
PEDALIACEAE	
Sesamum indicum Linn. Salit or selit Sesame	Oil and spice
UMBELLIFERAE	
Carum copticum Linn. Nech' Azmud Bishop's weed	Spice
Coriandrum sativum Linn. Dimbilal Coriander	Spice
RANUNCULACEAE	
Nigella sativa Linn. T'iku'r Azmud Black cumin	Spice
RUBIACEAE	
Coffea arabica Linn. Buna Coffee	Coffee
SOLANACEAE	
Capsicum frutescens Linn. Berbere or Sirbaberberi Chili pepper	Spice
Lycopersicon esculentum Mill. Timatin Small-fruited, cherry-size tomato	Vegetable

Note: The names of the plants are given in the following order: Latin,* local** and English.***

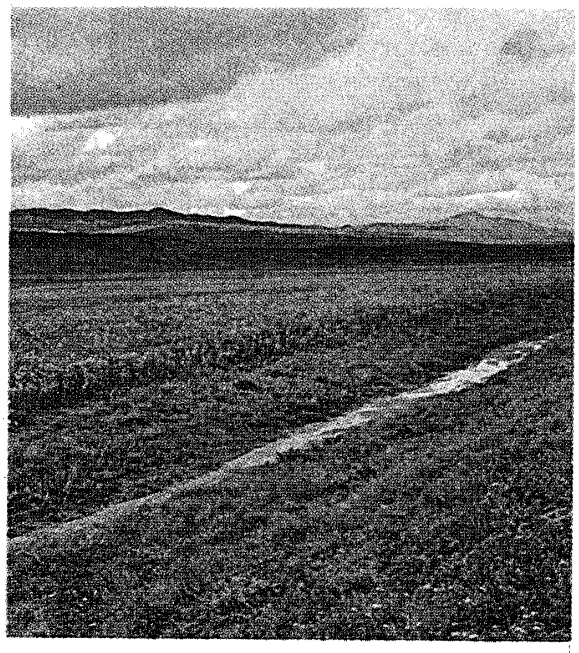
1. Desert : *Diplotaxis Harra* at Wadi Degra near Cailo
(Wadi : a desert valley)



2. Sandy beach : *Raphanus sativus* at Kilyos on the Black Sea



3. Rocky cliff on the coast : *Brassica oleracea* var. *macrocarpa* in the island Favignano



4. Cultivated land : *Brassica campestris* in wheat fields near Ankara

Photographs 1~4
Habitats of Brassica and allied genera